# Enterprise Search

Lama Saeeda

*lama.saeeda@fel.cvut.cz*

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# Overview

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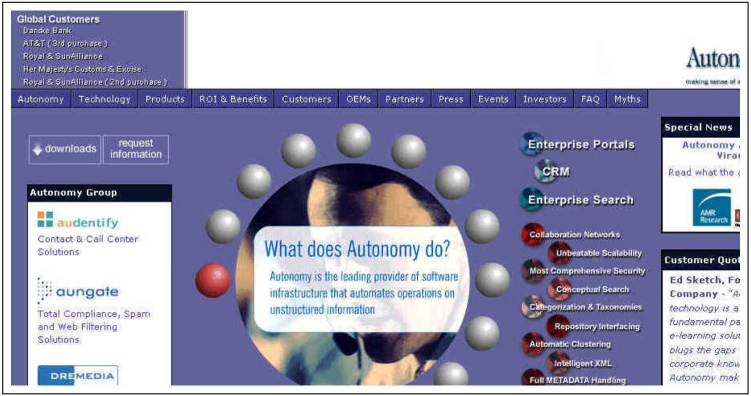
2. Definition
3. Differences from normal web search
4. Enterprise Search Components
5. Examples of enterprise search platforms and libraries

# Motivation

# Motivation

Where is the search box?



Global Customers
Danske Bank
AT&T (3rd purchase)
Royal & SunAlliance
Her Majesty's Customs & Excise
Royal & SunAlliance (2nd purchase)

Auton
making sense of a

Autonomy | Technology | Products | ROI & Benefits | Customers | OEMs | Partners | Press | Events | Investors | FAQ | Myths

downloads | request information

**Autonomy Group**

audentify
Contact & Call Center Solutions

aungate
Total Compliance, Spam and Web Filtering Solutions

DREMEDIA

What does Autonomy do?

Autonomy is the leading provider of software infrastructure that automates operations on unstructured information

Enterprise Portals
CRM
Enterprise Search
Collaboration Networks
Unbeatable Scalability
Most Comprehensive Security
Conceptual Search
Categorization & Taxonomies
Repository Interfacing
Automatic Clustering
Intelligent XML
Full METADATA Handling

**Special News**
Autonomy
Vira
Read what the
AMR Research

**Customer Quot**
Ed Sketch, Fo
Company - "A
technology is a
fundamental pa
e-learning solu
plugs the gaps
corporate know
Autonomy mak

Information systems need **Search** feature

# Definition

# Definition

**Enterprise search**

- is the practice of identifying and enabling specific content across the enterprise to be **indexed**, **searched**, and **displayed** to **authorized users**.
- is the organized retrieval of **structured** and **unstructured** data within your application.

# Differences from normal web search

# Enterprise vs. web search (Intranet vs. Internet)

- **Multiple data sources**
  websites, files, email, etc.
- **Collecting and indexing data**
  missed a key page?
- **Relevance and ranking algorithms**
  popular hits and page rank
- **Users**
  - Searchers are Knowledge workers
  - Context available: department, job, location...
- **Security**
  authenticated users
- **Single site, Single best document**
  federated search
- **Maintenance**

# Enterprise Search Components

# Enterprise Search Components

- Content awareness and collecting data
- Content processing and analysis
- Indexing
- Query processing
- Matching

# Collecting data

- Finding content and pulling it into the system
- **Crawlers** retrieve documents and other content
    - over protocols like HTTP
    - use adapters to connect to relational databases, document management systems, etc..

# Content processing

- **Identification** sentences, determined by periods or other punctuation marks

  *The operator operates successfully!*

- **Tokenization** breaking up text into tokens (words, phrases, symbols, etc..)

  *[The] [operator] [operates] [successfully]*

- **Normalization** tokens to lower case to provide case-insensitive search

  *[the] [operator] [operates] [successfully]*

# Content processing II

- **Stop-words removing** meaningless tokens, (there, so, other, etc..)
  _ *[operator] [operates] [successfully]*
- **Stemming and lemmatization** to get the normal form of the word
  _ *[operate] [operate] [success]*

.
.
.

- **Synonym expansion**: Controlled vocabulary, manually or automatically derived thesaurus, etc.. **Wordnet**
- **POS tagging** : (fishing, fished, fisher) one stem: the **book** on the table (noun), to **book** a flight (verb)

# Indexing

- The resulting terms are stored in an index, instead of storing the full text of the document
- Contains the dictionary of all unique words in the corpus
- Groups information into logical categories that in turn can be searched and return results to users based on how the particular search engine has categorized them.
- TF-IDF

# Indexing - TF-IDF

- **TF: Term Frequency**, how frequently a term occurs in **one document**.
  TF = (Number of times term t appears in a document / Total number of terms in the document)
- **IDF: Inverse Document Frequency**, how important a term is in the **corpus** IDF = log (Total number of documents / Number of documents with term t in it)

# Indexing - TF-IDF

$$TF * IDF(w) = TF(w).\frac{1}{DF(w)}$$

The word is more popular when it appears several times in a document

The word is more important if it appears in less documents

- $TF(w) \rightarrow$ term frequency (number of times a term occurs in a single document)
- $DF(w) \rightarrow$ document frequency (number of documents a term occurs in within the corpus)
- $TF * IDF \rightarrow$ relative importance of the word in the document

# Indexing - TF-IDF

the following example is the example about indexing

Query: *the example*

$$TF_{the} = 2$$

$$TF_{example} = 2$$

$$IDF_{the} = 0$$

$$IDF_{example} = \frac{1}{7}$$

The total score of this doc against the query is:

$$score = TF_{the} \times IDF_{the} + TF_{example} \times IDF_{example}$$

$$= 2 \times 0 + 2 \times \frac{1}{7} = \frac{2}{7} = 0.2857142857$$

# Searching

Enterprise search applications may allow

- general free-form keyword searching
- specialized query syntax to allow more specific queries
- a standardized query language like SQL or SPARQL

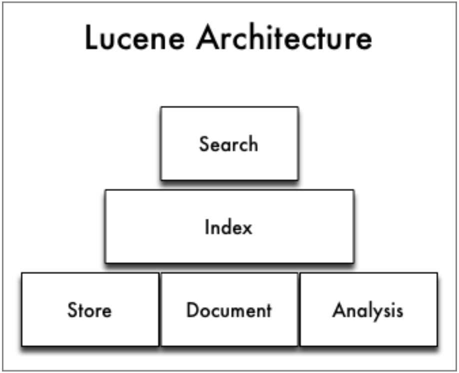
The query parser converts the query into a representation which can be used, along with the index, to determine matching results.

Query expansion for better performance (recall and precision)

# Examples of enterprise search platforms and libraries

# Lucene

- Java powerful open-source full-text search library
- Makes it easy to add full-text search capability to your application.
- **not** a complete application **but** a code library and API



# Lucene - Simple Indexing example

- in-memory index from some strings.

## Indexing

```
StandardAnalyzer analyzer = new StandardAnalyzer();
Directory index = new RAMDirectory();

IndexWriterConfig config = new IndexWriterConfig(analyzer);

IndexWriter w = new IndexWriter(index, config);
addDoc(w, ”Lucene in Action”, ”193398817”);
addDoc(w, ”Lucene for Dummies”, ”55320055Z”);
addDoc(w, ”Managing Gigabytes”, ”55063554A”);
addDoc(w, ”The Art of Computer Science”, ”9900333X”);
w.close();
```

# Lucene - Simple Indexing example II

- **addDoc()** is what actually adds documents to the index
- use of **TextField** for content we want tokenized, and **StringFiel** for id fields and the like, which we don't want tokenized.

### indexing - addDoc()

```
private static void addDoc(IndexWriter w, String title, String isbn) throws
IOException
Document doc = new Document();
doc.add(new TextField(”title”, title, Field.Store.YES));
doc.add(new StringField(”isbn”, isbn, Field.Store.YES));
w.addDocument(doc);
```

# Lucene - Simple query example

- We read the query from stdin, parse it and build a lucene Query out of it.

query

```
String querystr = ”your query keywords”;
Query q = new QueryParser(”title”, analyzer).parse(querystr);
```

# Lucene - Simple search example

- Using the Query we create a Searcher to search the index. Then a TopScoreDocCollector is instantiated to collect the top 10 scoring hits

**search**

```
int hitsPerPage = 10;
IndexReader reader = DirectoryReader.open(index);
IndexSearcher searcher = new IndexSearcher(reader);
TopDocs docs = searcher.search(q, hitsPerPage);
ScoreDoc[] hits = docs.scoreDocs;
```

# Elasticsearch

- Open source search server powered by Lucene under the hood
- Written in Java
- Cross platform
- Scalability and distributed architecture
- HTTP REST API
- Schema-less JSON documents
- Developed by *Elasticsearch BV*
- Near real-time search

# Elasticsearch

- Wikimedia
- Quora
- SoundCloud
- Github
- Netflix
- Foursquare

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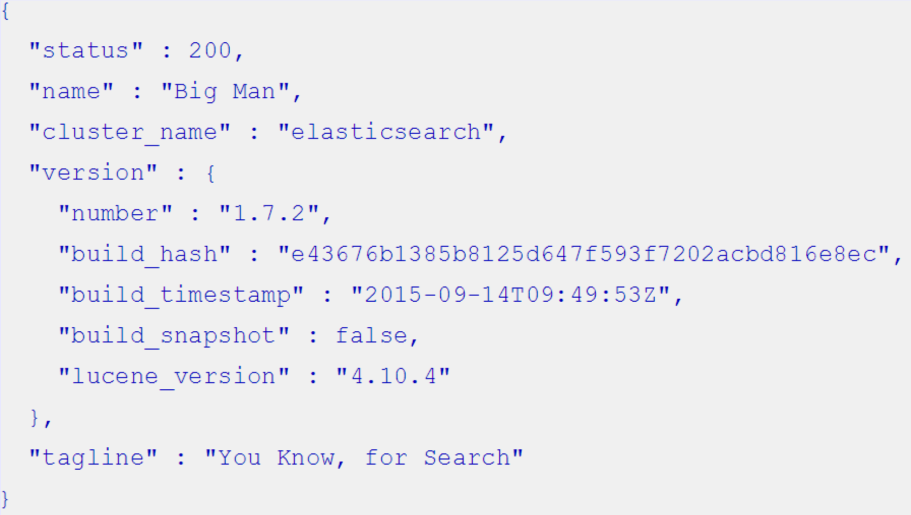
# Elasticsearch - Introduction Example

- **Download** the latest distribution from
  `https://www.elastic.co/downloads/elasticsearch`
- **Unpack** it on your machine
- **Run** it, by launching **elasticsearch**
- **Lunch** it from the web browser `http://localhost:9200`

# Elasticsearch - Introduction Example

## Result in the browser



```
{
  "status" : 200,
  "name" : "Big Man",
  "cluster_name" : "elasticsearch",
  "version" : {
    "number" : "1.7.2",
    "build_hash" : "e43676b1385b8125d647f593f7202acbd816e8ec",
    "build_timestamp" : "2015-09-14T09:49:53Z",
    "build_snapshot" : false,
    "lucene_version" : "4.10.4"
  },
  "tagline" : "You Know, for Search"
}
```

# Elasticsearch - Building a basic search app

## Create an Index

```
PUT /myapp?pretty
```

## Index a Document

```
PUT /myapp/tweet/1?pretty
{
  "name": "John Doe",
  "tweet": "I think elasticsearch is AWESOME",
  "date" : "2013-06-03",
  "loc" : {
       "lat": 13.4,
       "lon": 52.5
  }
}
```

## Create an Index - Response

```
{
 "_index" : "myapp",
 "_type" : "tweet",
 "_id" : "1",
 "_version" : 1,
 "result" : "created",
 "_seq_no" : 0,
 "_primary_term" : 1
}
```

## Get the Document

```
GET /myapp/tweet/1?pretty
```

## Get the Document - Response

```
{
 "_index" : "myapp",
 "_type" : "tweet",
 "_id" : "1",
 "_version" : 1,
 "found" : true,
 "_source" : { ...OUR TWEET... }
}
```

## Update the Document

```
PUT /myapp/tweet/1?pretty
{
  "name": "Jahn Doe",
  "tweet": "I think elasticsearch is AWESOME",
  "date" : "2013-06-03",
  "loc" : {
       "lat": 13.4,
       "lon": 52.5
  }
}
```

## Delete the Document - Response

```
Delete /myapp/tweet/1?pretty
```

PS: Response: ”version” : 3

# Indexing

$Doc\#1 \rightarrow$ *_ [operate] [operate] [success]*

'operate' : [1, 47, 72],
'success' : [1, 55, 92, 107],

# Inverted Index

*Doc*#1 → _ *[operate] [operate] [success]*

```
inverted_index = {
      'operate' : [1, 47, 72],
      'success' : [1, 55, 92, 107],
      'search' : [34, 92,, 119],
      ' zebra' : [15, 34, 55, 107],
}
```

# Mapping

```
{
 "tweet": {
  "properties": {
   "name": { "type": "string" },
   "tweet": { "type": "string" },
   "date": { "type": "date" },
   "rt": { "type": "double" },
   "loc": { "type": "geo_point" },
}}}
```

PS: Do not change the mapping of existing field

# Mapping

Full text : (defult)

```
{ "type": "string", index: "analyzed" }
```

Exact string

```
{ "type": "string", index: "not_analyzed" }
```

Not searchable

```
{ "type": "string", index: "no" }
```

## Search the index - Empty Search

```
GET /myapp/_search
{
 "query": { "match_all": {} }
}
```

## Response

```
{
 "took" : 2,
 "timed_out" : false,
 "_shards" : {
  "total" : 5,
  "successful" : 5,
  "failed" : 0
 },
 "hits" : {
    "total" : 14,
  "max_score" : 1.0,
  "hits" : [ {...}]
  }
}
```

# Filters vs. Queries

**Filters**

- Exact matching
- binary yes/no
- fast
- cacheable

**Queries**

- full text search
- relevance scoring
- heavier
- not casheable

Query:

```
{ "match": {"tweet": "search" }}
```

Filter:

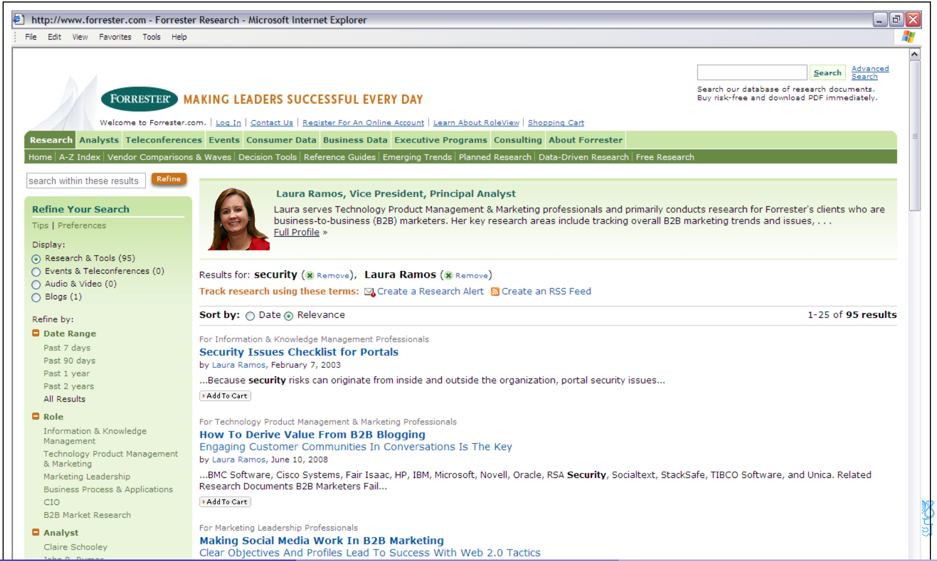
```
{ "term": {"date": "2018-1-3" }}
```

# Filtered queries & Boolean queries

```
GET /bank/_search
{
  "query": {
    "bool": {
      "must": { "match_all": {} },
      "filter": {
        "range": {
          "balance": {
            "gte": 20000,
            "lte": 30000
          }
        }
      }
    }
  }
}
```

$$Boolean \rightarrow must, should, must\_not$$

# Aggregations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search within these results | Refine

**Refine Your Search**

Tips | Preferences

Display:

- ● Research & Tools (95)
- ○ Events & Teleconferences (0)
- ○ Audio & Video (0)
- ○ Blogs (1)

Refine by:

**Date Range**

- Past 7 days
- Past 90 days
- Past 1 year
- Past 2 years
- All Results

**Role**

- Information & Knowledge Management
- Technology Product Management & Marketing
- Marketing Leadership
- Business Process & Applications
- CIO
- B2B Market Research

**Analyst**

- Claire Schooley

**Laura Ramos, Vice President, Principal Analyst**

Laura serves Technology Product Management & Marketing professionals and primarily conducts research for Forrester's clients who are business-to-business (B2B) marketers. Her key research areas include tracking overall B2B marketing trends and issues, . . .
Full Profile »

Results for: **security** (Remove), **Laura Ramos** (Remove)

Track research using these terms: Create a Research Alert | Create an RSS Feed

**Sort by:** ○ Date ● Relevance — 1-25 of **95 results**

For Information & Knowledge Management Professionals
**Security Issues Checklist for Portals**
by Laura Ramos, February 7, 2003
...Because **security** risks can originate from inside and outside the organization, portal security issues...
Add To Cart

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**How To Derive Value From B2B Blogging**
Engaging Customer Communities In Conversations Is The Key
by Laura Ramos, June 10, 2008
...BMC Software, Cisco Systems, Fair Isaac, HP, IBM, Microsoft, Novell, Oracle, RSA **Security**, Socialtext, StackSafe, TIBCO Software, and Unica. Related Research Documents B2B Marketers Fail...
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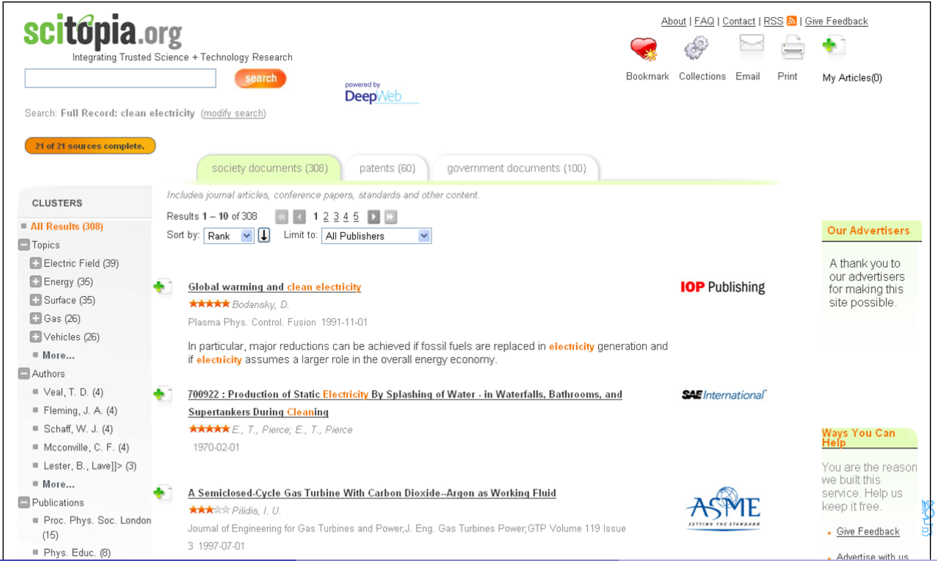
Clear Objectives And Profiles Lead To Success With Web 2.0 Tactics

# Aggregations



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Email
Print
My Articles(0)

Search: Full Record: clean electricity (modify search)

21 of 21 sources complete.

Includes journal articles, conference papers, standards and other content.

Results 1 – 10 of 308 1 2 3 4 5

Sort by: Rank Limit to: All Publishers

- All Results (308)
- Topics
  - Electric Field (39)
  - Energy (35)
  - Surface (35)
  - Gas (26)
  - Vehicles (26)
  - More...
- Authors
  - Veal, T. D. (4)
  - Fleming, J. A. (4)
  - Schaff, W. J. (4)
  - Mcconville, C. F. (4)
  - Lester, B., Lave]]> (3)
  - More...
- Publications
  - Proc. Phys. Soc. London (15)
  - Phys. Educ. (8)

Global warming and clean electricity
★★★★★ Bodansky, D.
Plasma Phys. Control. Fusion 1991-11-01
In particular, major reductions can be achieved if fossil fuels are replaced in electricity generation and if electricity assumes a larger role in the overall energy economy.

700922 : Production of Static Electricity By Splashing of Water - in Waterfalls, Bathrooms, and Supertankers During Cleaning
★★★★★ E., T., Pierce; E., T., Pierce
1970-02-01

A Semiclosed-Cycle Gas Turbine With Carbon Dioxide-Argon as Working Fluid
★★★☆☆ Pilidis, I. U.
Journal of Engineering for Gas Turbines and Power;J. Eng. Gas Turbines Power;GTP Volume 119 Issue 3 1997-07-01

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# Aggregations

```
GET /bank/_search
{
 "size": 0,
 "aggs": {
  "group_by_state": {
   "terms": {
    "field": "state.keyword"
   }
  }
 }
}
```

# Aggregations

```
GET /bank/_search

{
  "size": 0,
  "aggs": {
    "group_by_age": {
      "range": {
        "field": "age",
        "ranges": [
          {
            "from": 20,
            "to": 30
          },
          {
            "from": 30,
            "to": 40
          },
          {
            "from": 40,
            "to": 50
          }
        ] },
```

```
"aggs": {
        "group_by_gender": {
          "terms": {
            "field": "gender.
                 keyword"
          },
          "aggs": {
            "average_balance": {
              "avg": {
                "field": "balance"
              }
            }
          }
        }
      }
    }
  }
}
```

# Solr

- Also built on Lucene
  - So similar feature set
  - Also exposes Lucene functionality, like Elastic Search, so easy to extend.
- A part of Apache Lucene project
- Perfect for Single Server search
- Clustering is there. But it's definitely not as simple as ElasticSearch
- Solr is for text search while Elasticsearch is for filtering and grouping, the analytical query workload, and not just text search.

# Evaluation of search system

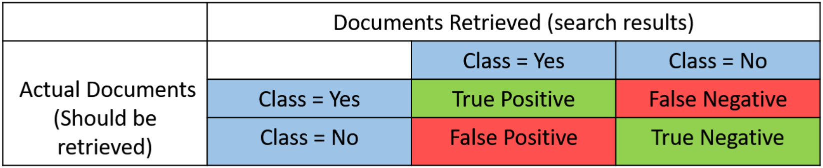
# Evaluation of search system

$$\text{precision} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{retrieved documents}\}|}$$

$$\text{recall} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{relevant documents}\}|}$$

$$\text{Precision} = \frac{tp}{tp + fp}$$

$$\text{Recall} = \frac{tp}{tp + fn}$$



| | Documents Retrieved (search results) | | |
|---|---|---|---|
| Actual Documents (Should be retrieved) | | Class = Yes | Class = No |
| | Class = Yes | True Positive | False Negative |
| | Class = No | False Positive | True Negative |

# What is bad search?

- No search box
- Too many hits: Return 10,000 hits when the average user looks at the top-20 only
- Bad scoring: The most relevant item is not at the top of the list
- Poor duplicate detection: Too many similar documents
- Inability to judge user intent: spell checking,recommendation system, auto complete.

# The End

Thank You